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# Reduced solar-induced chlorophyll fluorescence from GOME-2 during Amazon drought caused by dataset artifacts

## Abstract

Recently, Yang et al. (2018) reported a decrease in solar-induced chlorophyll fluorescence (SIF) during 2015/2016 El Niño event albeit the increase in enhanced vegetation index (EVI). They interpreted the reduced SIF as a signal of reduced ecosystem photosynthesis. However, we argue that the reduced SIF during 2015/2016 is caused by a decreasing trend of SIF due to sensor degradation and the satellite overpass time is critical for drought impact assessment.

## Introduction

Yang et al. (2018) reported an increase in enhanced vegetation index (EVI) and incoming solar radiation, together with a decreased solar-induced chlorophyll fluorescence (SIF) signal in Amazon forest during the 2015/2016 El Niño event, and suggested that although the greenness of the forest increased, the reduced SIF signal demonstrated an reduced of photosynthetic capacity during the drought. We argue that the decreased SIF signal may be caused by the artifacts of the datasets and does not necessarily support the decrease in photosynthesis in Amazon.

First, the SIF dataset Yang et al. (2018) used from the GOME-2 instruments exhibited a strong decreasing trend that is caused by instruments degradation (Figure 1, also suggested in the dataset description; https://avdc.gsfc.nasa.gov/pub/data/satellite/MetOp/GOME_F/README_GOME-F_v26-v27.pdf GOME-2 FLOURESCENCE README FILE, accessed on 6 March 2018). This trend spreads across the entire Amazon basin for both satellite sensors (−1.1%/year on average for MetOp-A, same as the global average trend −1.1%/year; −3.3%/year for MetOp-B, global average trend is −1.4%/year), and its spatial pattern is also independent from precipitation gradient or anomalies. This can be the major cause for the observed anomalies during the later period (2015/2016) deviating from their multiyear average, and can also explain the inconsistency of the spatial extent of the drought reported by Yang et al. (2018) with other study (Jiménez-Muñoz et al., 2016).

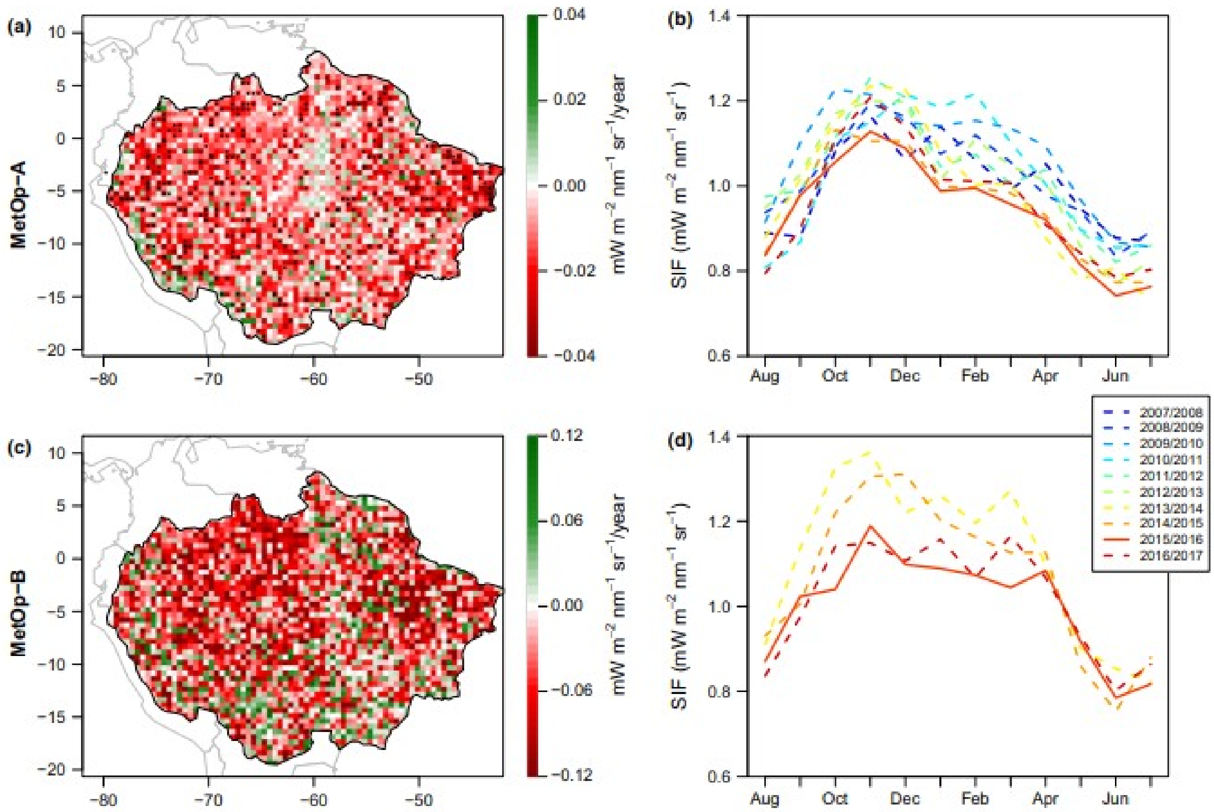


**FIGURE 1** The spatial pattern of Sen's slope trend for annual average SIF for (a) MetOp-A and (c) MetOp-B. The annual average starts from August and end at July. Black dots in (a) represent the trends are significant at a 0.05 level (two-sided Mann–Kendall test). The seasonal pattern of average SIF for the Amazon region from (b) MetOp-A and (d) MetOp-B. [Color figure can be viewed at wileyonlinelibrary.com]

Second, SIF signal is driven largely by the absorbed photosynthetically active radiation (PAR) by chlorophyll ($APAR_{chl}$ = PAR × $fPAR_{chl}$; Verrelst et al., 2016). As vegetation indices (eg, EVI) are strongly correlated with $fPAR_{chl}$, we would expect to see concomitant responses in both SIF and vegetation indices. Considering the reported increase in vegetation greenness and incoming solar radiation, it is most likely that, if the decrease in SIF did exist, was caused by the decrease in fluorescence yield. The fluorescence yield dynamically responds to the diurnal stress on photosynthesis process due to the closure of the stomata (Lee et al., 2013). However, during the morning overpass of the satellites (9:30 am), the plants will experience little stress when the incoming radiation, air temperature and vapor pressure deficit are relatively low. The fluorescence yield can remain unchanged in the early morning even during drought, but can also exhibit a strong diurnal variation which is related to diurnal changes of drought stress (Amoros-Lopez et al., 2008). Thus, using SIF observation at different time of the day may give different drought severity prediction. Although sustained drought stress may also reduce the fluorescence yield (Alonso et al., 2017), it would then lead to a decrease in vegetation greenness (Sun et al., 2015; Yoshida et al., 2015) which is not shown in this drought event.

In conclusion, the observed decrease in SIF during 2015/2016 in Amazon may be caused by dataset artifact or at least overestimated for failing to take this trend component into consideration. In addition, the timing of the satellite observation further adds to the uncertainty of using SIF to infer the vegetation photosynthesis response. Lacking support from other independent datasets, the conclusion drawn appears questionable.

Keywords: Amazon forest, drought, photosynthesis, solar-induced chlorophyll fluorescence, vegetation activity

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